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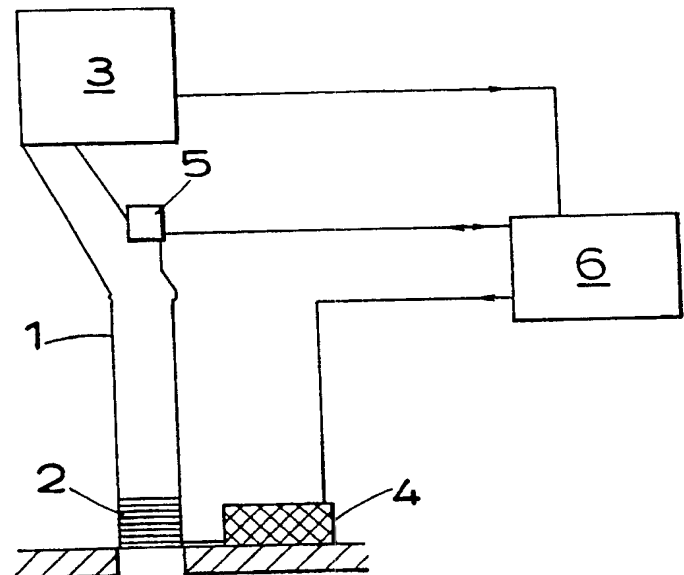
G4V

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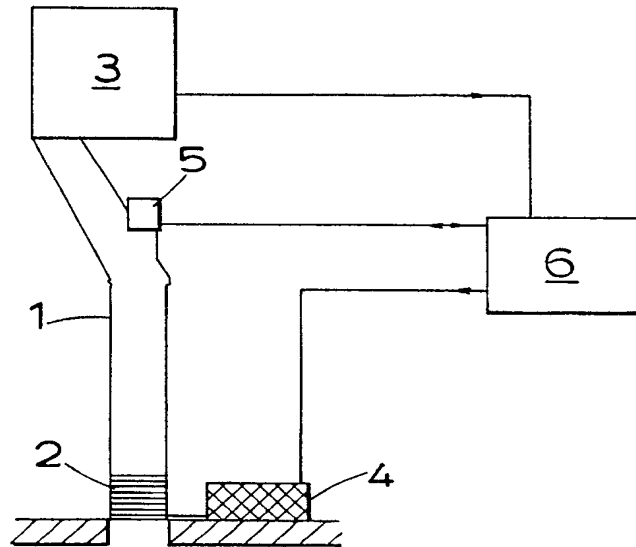
G01S

(54) **Monitoring the level of a stack of coins by a pulse-echo method**

(57) The level of a stack of coins 2 in a stack tube 1 is monitored by an ultrasonic transducer 5 disposed above the stack tube 1. The transducer 5 directs a train of ultrasonic pulses down towards the top of the stack and measures the transit time between the emitted and reflected pulses. The monitoring apparatus is particularly suitable for use in a gaming, amusement, vending or change machine which has a number of stack tubes 1 from which coins are payed out by a payout device 4 under the control of a control unit 6.



GB 2 190 749 A



SPECIFICATION

Monitoring the level of a stack of coins

5 This invention relates to a method of and
apparatus for monitoring the level of a stack
or heap of coins (and by this phrase we in-
clude also equivalents such as tokens). It is
particularly applicable to machines which in-
10 clude equipment for storing coins and paying
them out from stack tubes or payout hoppers.
In gaming and amusement machines, vend-
ing machines, ticket machines, change-givers
and the like it is usual to store the incoming
15 coins in so-called stack tubes and pay them
out from the bottoms of the tubes by means
of a solenoid. It is important that the stack
tubes should not become empty, at least not
without warning, and there are various ar-
20 rangements for ensuring that they are topped
up, or at least for ensuring that action is
taken if they are running low, e.g. diversion of
the pay-out to coins of a different denomina-
tion. Also, when the machines are opened up
25 to collect the money in them, the collector
has to see that there is an adequate 'float' left
in each stack tube.

There is therefore a need for means to de-
tect automatically when the level of coins in
30 the tube is above or below a certain point and
various proposals have been made to meet
this need. For example a micro-switch may be
placed alongside the tube with its actuating
arm protruding into the tube so that the pres-
35 ence of a coin at the given height closes the
switch. However this only tells one whether
the top of the stack of coins is above or
below that level, and if a more accurate indi-
cation is required several such switches, verti-
40 cally spaced apart, are required. The same is
true of another possibility, in which a lamp
directs a beam of light across the stack tube
to fall on a photo-cell (see GB Patent Specifi-
cation 2 106 640 A). It has also been pro-
45 posed to use the Hall effect (with a non-
metallic stack tube), or simply to count the
coins in and count the coins out and keep a
running total. This last-mentioned proposal,
however, suffers from the drawback of cumu-
50 lative error building up, for example if two
coins drop into the tube together and are
counted as one. It is also upset if any coins
are manually added or extracted, as will hap-
pen if the collectors are instructed to leave
55 the stack tubes with a predetermined float in
them.

The aim of the invention is to provide a
much better monitoring of the level of coins in
a stack tube but without the complication and
60 bulk that would be involved in multiple swit-
ches or photo-cells.

According to one aspect of the invention
we propose a method of monitoring the level
of a stack or heap of coins comprising the
65 steps of transmitting and directing a signal to-

wards the top of the stack or heap and mea-
suring the time taken by the signal to be
reflected back to a receiver. Put shortly, we
use a form of radar or sonar. The signal is
70 preferably directed downwards, substantially
parallel to the axis of a stack of coins (which
is not necessarily vertical) although it would
be inclined to some degree. In a preferred
arrangement, an ultrasonic train of pulses is
75 sed, generated by a suitable transmitting
transducer and the reflected pulses are picked
up by a receiving transducer alongside (or it
could be the same one). The system gives a
continuous indication of the exact height of
80 the stack within any range determined by the
designer of the equipment.

Although ultrasonic signals are preferred,
other forms could be used, e.g. electromag-
netic radiation (radar) or optical interferometry.
85 The essential thing is that a signal is obtained
giving the position of the surface of the up-
permost coin in the stack or heap without any
mechanical feelers or other direct contact.

The output, basically in the form of a transit
90 time between the emitted and reflected
pulses, may be translated into a number
representing the actual number of coins in the
stack, this number being used for whatever
further purpose it is required, e.g. for warning
95 of a low stack, or for directing coins to alter-
native stacks when the one in question is be-
coming full. Where coins are being paid out
as change in a number of different denomina-
tions from different stacks, as in a change-
100 giver, the signals from the different stacks
may be used to modify continuously the com-
position of the payout to suit the relative
availability of the various denominations.

According to another aspect of the inven-
105 tion there is provided apparatus for monitoring
the level of a stack or heap of coins according
to the method described above and compris-
ing a transmitting transducer which transmits
the signal or train of pulses towards the top
110 of the stack or heap, a receiving transducer
which receives the signal or train of pulses
reflected back from the top of the stack or
heap, and time-measuring means for measur-
ing the transit time between the emitted and
115 reflected signals or pulses.

Conveniently, a single ultrasonic transducer
may serve both as the transmitter and the
receiver, and a typical frequency could be
40KHz, although other frequencies might be
120 used, depending on the maximum and mini-
mum heights to be expected, which would de-
termine the lower and upper limits on the
pulse reaction time.

The method and apparatus in accordance
125 with the present invention will now be de-
scribed, by way of example only, with refer-
ence to the accompanying drawing. The draw-
ing shows a machine, for instance a gaming,
amusement, vending or change machine, hav-
ing a stack tube 1 in which coins 2 are
130

stored, a coin input device 3 which may include coin validation means and a payout device 4 for paying coins out from the bottom of the stack tube 1.

- 5 The machine also includes apparatus for monitoring the level of coins 2 in the stack tube 1. This apparatus comprises an ultrasonic transducer 5 disposed above the stack tube and which serves both as a transmitter for
10 transmitting and directing a train of ultrasonic pulses down the tube and as a receiver for receiving the train of pulses reflected back from the top coin of the stack in the tube 1. The transducer may also include a timer which
15 measures the transit time between the emitted and reflected pulses, and the height of the coin stack can be calculated from this measured transit time by a control unit 6 connected to the transducer 5.
- 20 Preferably, the control unit 6 translates stack height signals from the transducer 5 into a number representing the actual number of coins in the stack and this number is continuously monitored. The control unit 6 may also
25 receive 'coin-in' signals from the coin input device 3 and send or receive 'payout' signals to or from the payout device 4. In this manner the control unit may be used, for example, to detect unauthorised removal of coins from
30 the stack tube, to give a warning of a low stack or, where there are a plurality of coin stacks, to control the payout in accordance with the number of coins in each stack tube.

It will be appreciated that the method described above with reference to the drawing
35 could, in principle, be used to monitor the level of a number of coins stacked on edge, or even the level of a heap of coins in, say, a payout hopper or cash box. For instance, it
40 might be appropriate to use more than one transmitting/receiving transducer to monitor the level of a heap of coins.

CLAIMS

- 45 1. A method of monitoring the level of a stack or heap of coins or the like comprising the steps of transmitting and directing a signal towards the top of the stack or heap and measuring the time taken for the signal to be
50 reflected back to a receiver.
2. A method according to claim 1 in which the signal is directed downwards, substantially parallel to the axis of a stack of coins.
3. A method according to claim 1 or claim
55 2 in which a train of pulses is generated by a transmitting transducer and directed towards the top of the stack or heap and the reflected train of pulses is picked up by a receiving transducer to give a continuous indication of
60 the height of the stack or heap.
4. A method according to claim 3 in which a train of ultrasonic pulses is used.
5. A method according to any of the preceding claims in which the measured transit
65 time between the emitted and reflected signal

or pulses is translated into a number representing the number of coins in the stack.

6. Apparatus for monitoring the level of a stack or heap of coins according to the
70 method of any of the preceding claims comprising a transmitting transducer which transmits the signal or train of pulses towards the top of the stack or heap, a receiving
75 transducer which receives the signal or train of pulses reflected back from the top of the stack or heap, and time-measuring means for measuring the transit time between the emitted and reflected signals or pulses.

7. Apparatus according to claim 6 in which
80 a single ultrasonic transducer serves both as the transmitter and the receiver.

8. Apparatus for monitoring the level of a stack of coins substantially as described herein with reference to the accompanying
85 drawing.

9. A gaming, amusement, vending or change machine having a number of stack
90 tubes in which coins are stored and which incorporates apparatus for monitoring the level of coins in each stack tube in accordance with any of claims 6 to 8.

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